

## Analysis of Students' After-School Mobile-Assisted Artifact Creation Processes in a Seamless Language Learning Environment

Lung-Hsiang Wong

Learning Sciences Lab., National Institute of Education, Nanyang Technological University, Singapore // lunghsiang.wong@nie.edu.sg

(Submitted November 23, 2011; Revised February 24, 2012; Accepted April 23, 2012)

### ABSTRACT

As part of a learner's learning ecology, the informal, out-of-school settings offer virtually boundless opportunities to advance one's learning. This paper reports on "Move, Idioms!", a design for Mobile-Assisted Language Learning experience that accentuates learners' habit of mind and skills in making meaning with their daily encounters, and associating those with the language knowledge learned in formal learning settings. The students used smartphones on a 1:1, 24x7 basis to capture photos in real-life contexts as artifacts related to Chinese idioms, made sentences with the idioms, and then posted them onto a wiki space for peer reviews. In this paper, we focus on investigating students' cognitive processes and patterns in artifact creations in informal settings. Our analysis and interpretation of such student activities is framed by the notion of Learner-Generated Context (LGC) (Luckin, 2008), a reconceptualization of 'learning contexts' that implies greater learner autonomy. Through two case studies, we gained better understanding in the impact of LGC and how it is crystallized in seamless learning processes with the interplay of physical settings, parental involvements and the mediation of mobile technology.

### Keywords

Mobile Assisted Language Learning (MALL), Seamless learning, Informal learning settings, Parental support, Learner Generated Context (LGC)

### Introduction

How can learners' motivation and competencies in making meaning with their daily encounters, and associating those with their formal learning gains, be nurtured through their participations in (teacher-)facilitated seamless learning processes? This is one of the major research issues of our design-based research (DBR) study in exploring a seamless learning design for Mobile Assisted Language learning (MALL), "Move, Idioms!" Seamless learning, the overarching learning notion of our study, is defined by Chan et al. (2006) as an approach through which a student can learn whenever and wherever she is keen to learn in a variety of scenarios. Using the personal mobile device as a mediator, she can easily switch from one context to another (formal and informal learning, personal and social learning, physical and digital realities, etc.) in her learning journey.

In the study, we facilitated a Primary 5 (11-year-old) class in Singapore to study 48 Chinese idioms (with 8 additional conjunctions to experiment on the versatility of the learning design) over 10 months. Apart from on-campus idiom/conjunction lessons with contextualized and small-group learning activities (formal/collaborative/physical-space), the students were each assigned a smartphone for their 24x7 access. With the smartphones, they took photos in daily lives and made sentences with the idioms/conjunctions (informal/personal-or-collaborative/physical-space). They then posted those artifacts onto a wiki space for peer review (informal/collaborative/digital-space).

In this paper, we focus on the students' processes and products of the artifact creation in informal, out-of-school settings, supported by mobile technology. We consider all these learning experiences as forms of personal or social meaning making. That is, students interpreted their daily encounters and improvised the contexts either alone or with other people's participations. Subsequently, they articulated their renewed understanding of such authentic contexts by associating them with the vocabularies (idioms and conjunctions are special forms of vocabularies) that they learned in formal lessons. Our analysis and interpretation of such student activities is framed by the notion of Learner Generated Context (LGC) (Luckin, 2008). Through our investigation of the roles of physical settings and the technology in mediating children's out-of-school activities, we hope to advance the research field's understanding in the nature of seamless learning, through articulating: (1) the boundless learning opportunities that informal learning settings may potentially bring to the learners and (2) what it takes for the students to be able to identify and seize such latent opportunities to advance their learning.

## Literature review

The sum total of the child's learning experience is not just what happens within the walls of the school. Many studies highlight that external factors such as experiences in the informal learning environments (Falk & Dierking, 1998; Hull & Schultz, 2001) have an impact on a young learner's overall learning success. Barron (2006) defined a learning ecology as "the set of contexts found in physical or virtual spaces that provides opportunities for learning" (p.195). Based on the same perspective, Barab and Roth (2006), and Luckin (2008), advocated the establishment of individual learners' cross-context and perpetual learning ecology that is genuinely learner centric.

A particular significant aspect of learning ecology is the notion of learning contexts. The definition of "context" according to the Merriam-Webster Dictionary is, "The interrelated conditions in something exists or occurs." Past educational research studies, including research in mobile and ubiquitous learning, tended to treat contexts an external "shell" surrounding the learners. That is, learners are traditionally consumers in (relatively static) contexts created for them (Whitworth, 2008). Lonsdale, Baber, Sharples and Arvanitis (2004) challenged this conventional view by redefining "context" as a *dynamic* process with historical dependencies. The new perspective prompted Luckin (2008) to put forward the notion of learner-generated contexts (LGC). The reconceptualized "learning context" embodies learners' relevant prior knowledge and experience, their personal or group-level learning goals, and their *emergent* interactions with each other and with the environment. Therefore, the environment (e.g., a ubiquitous-enabled botanic garden for students' field trip) is no longer equivalent to the context, but merely the learning space that facilitates learners in generating their learning contexts on-the-fly. This reconceptualization is congruent with Wong, Chen and Jan's (in press) exposition that learners ought to assume greater autonomy and agency in deciding what and how to learn, and being able to self-identify and appropriate learning resources across different learning spaces to mediate their learning, rather than always being inhibited by predefined learning goals and resources within externally (e.g., the teacher or the adaptive technology) imposed learning contexts.

Among all the potential learning resources that the younger learners can access to, parental involvement is a crucial but often neglected element in educational research studies (exceptions are, e.g., Beals & Snow, 1994; Hill & Tyson, 2009). Parental involvement in children's learning may come in different forms, such as monitoring their children's home learning with the aid of technologies, and perhaps communicating with the teachers to share their observations in the children's learning. The technology advancement opens up new opportunities for the parents to actively experience what and how their children learn, apart from lower level learning regulation purposes. In particular, Lewin and Luckin (2010) posited that in order to engender parental involvement, activities need to be designed in a manner that encourages parent-child collaboration. As such strategies may pose additional challenges to both the researchers and practitioners, it is not surprising that the aspect of parental involvement had been underexplored in the existing studies on mobile seamless learning, according to Wong & Looi's (2011) analysis of the relevant literature.

The notion of LGC provides a new outlook to teachers' learning design and learners' autonomous learning. It offers the potential to facilitate more open-ended and personalized learning that aims to transform students to become autonomous learners who can create their own learning contexts from their learning spaces. Such a notion has been well-articulated in the literature (e.g., Dourish, 2004; Luckin, 2008; Whitworth, 2008) but has not yet been applied to interpret and analyze authentic learning processes. It is timely for us to scrutinize the potential of LGC to be employed in designing or analyzing seamless learning experiences.

## Study description

### *The design of the seamless language learning process*

As a fundamental component of language learning, vocabulary learning is often delivered in conventional ways, such as providing abstract definitions and sentences taken out of the context of normal use (Jiang, 2000). Such pedagogical strategies may pose a greater problem for learning of context-dependent vocabularies, such as conjunctions and idioms. The complex nature of such vocabularies may result in highly context-dependent appropriateness of their usage. There are many possible real-life contexts where such vocabularies could suitably, or unsuitably but often mistakenly, be used. These are almost impossible to be prescribed in a simple definition (Wong & Looi, 2010).

Recognizing both the importance and the limitation of formal, in-class language learning, language learning theorists have been advocating the integrations of formal and informal (Titone, 1969), and personal and social (Noel, 2001) language learning. Such advocates mesh well with the notion of seamless learning. Informed by the theories, we developed a cyclic, customizable learning experience design of “Move, Idioms!” (see Figure 1). As such a learning experience emphasizes *production* of linguistic artifacts (i.e., language output activities), it is known as productive language learning in the literature.

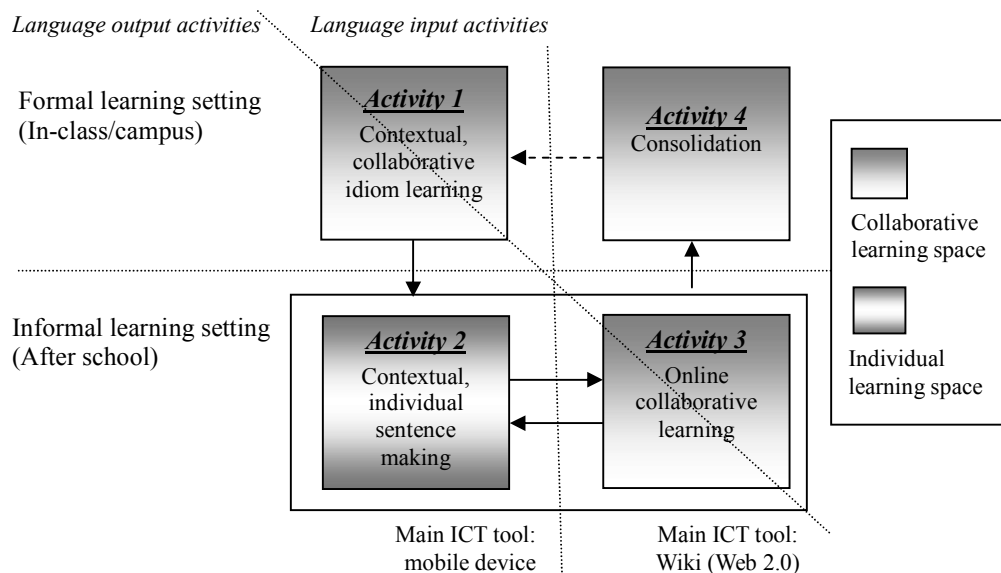


Figure 1. The “Move, Idioms!” learning experience design

The processes of the four activities are described below:

**Activity 1 – In-class/on-campus contextual idiom learning:** The activities are conducted to motivate and prepare students to engage in subsequent Activity 2 on their own. During each lesson, new idioms are introduced to the students via multimedia presentations. The teacher then facilitates contextualized learning activities, such as facilitating the students to work in small groups to take photos in the campus to illustrate the idioms. Strategies of artifact creation are also introduced by the teacher, such as sentences should incorporate suitable contexts. For example, albeit grammatically correct, the sentence (with the idiom being underlined) 我在手舞足蹈 (I am dancing for joy) is undesirable since it is decontextualized in use. However, e.g., “I am dancing for joy for winning the top prize at the dance competition.” is contextual and therefore acceptable.

**Activity 2 – Out-of-class, contextual, independent sentence making (*the focus of this paper*):** Students carry the mobile phones assigned to them 24x7 in order to identify or create contexts in their daily lives which can be associated with the idioms. They then take photos, make sentences by using the idioms to describe the photos, and post them onto a class wiki space. We create one wiki page for each idiom for students to post their artifacts. This offers convenience for comparing student-generated contexts pertaining to the same idioms.

**Activity 3 – Online collaborative learning:** Students perform peer reviews on the wiki by commenting on (with the comment tool of wiki), correcting or improving their peers' sentences (by modifying the sentences posted on the wiki pages).

**Activity 4 – In-class consolidation:** Each student group is assigned a few existing student artifacts on the same wiki page with a mixture of correct, ambiguous and erroneous usages of an idiom. The groups compare the artifacts and revise the sentences where necessary. Subsequently, teacher-facilitated classroom discussion helps clarify contradictory views and facilitate class-wide debates.

One of the core learning activities in “Move, Idioms!” is photo taking and sentence making in daily life, supported by smartphones. Although similar activities can be carried out with the aid of photos found on the Internet or picture

clippings from printed materials, we instead leverage mobile technology to motivate the students to become active meaning maker on the encounters in their daily life, and even creating contexts out of the informal spaces. This is an important learning-anywhere-and-anytime-*ish* habit of mind not just for the “Move, Idioms!” study, but for all general seamless learners. In this case, the student artifacts are directly arisen from their very own life experiences; they would therefore assume greater ownership in their self-generated artifacts. Our design decision can be further justified by the need of language learning, as traditional second language classroom practices have been criticized by the scholars (e.g., Jiang, 2000; Tedick & Walker, 2009) for the excessive amount of “secondhand” experiences (e.g., contexts in the textbook passages, or teacher-supplied printed/downloaded materials) being employed in the instructions. Learners ought to apply, and reflect upon, their target language in the authentic environment to enhance learning internalization.

## Research design

In view of the complex interplay between the students’ learning experiences as well as the technology and pedagogy involved, we adopted the Design-based research (DBR) methodology (Brown, 1992) to conduct our study. This method stresses upon the systematic study on the interdependence of design elements, and the importance of examining emerging issues through iterative refining processes. It allows us to collect and analyze rich and relevant data to bear on the many simultaneously interacting factors that shape the learning we envisage. This will then help to improve the design and shape the development of the pedagogy (Design-Based Research Collective, 2003; Wong, Boticki, Sun, & Looi, 2011).

To date, we have implemented two DBR cycles of “Move, Idioms!” The first cycle was a pilot study which took place during July-September 2009 that involved a Primary 5 (11-year-old) class. Through post-intervention student interviews, we obtained data on how students and parents co-created artifacts. The second cycle (this paper’s focus) took place in January-November 2010. Another class of 34 Primary 5 students, with mixed abilities in Chinese Language, participated in the study. Each of them was assigned a Samsung Omnia II smartphone running MS Windows Mobile 6.5. The phone comes with built-in camera, Wi-Fi access, Internet browser and English/Chinese text input. The researchers and a group of Chinese teachers co-designed eight “Activity 1” and two “Activity 4” lessons which were then enacted by the teacher of the experimental class. The lessons were paced the way that there were 2- to 4-week intervals in between them. Meanwhile, students carried out “Activity 2” and “Activity 3” continuously at their own time. We developed and installed a simple application on their smartphones so that they can perform the following tasks on one interface: (1) taking photos; (2) assembling photos; (3) constructing sentences or paragraphs; (4) posting the artifacts onto the wiki pages of their choice; (5) pick and mix existing photos saved in the smartphone photo album to create new artifacts.

Recognizing such a seamless learning design as an opportunity to better involve parents in advancing their children’s learning during “Activity 2,” we decided to further investigate and enhance this aspect. We organized a “meet-the-parents” session prior to the second cycle. In the session, we briefed the parents of the participating students about the benefits and challenges of mobile seamless learning in general, and suggested to them some strategies to regulate or participate in the students’ after-school use of smartphones. A mother-daughter dyad from the first cycle was invited to share with other parents their fond experiences of working together in co-creating artifacts, mostly in a spontaneous and opportunistic manner. Some parents who attended the session found the sharing inspiring and indicated their willingness to give it a try.

Informed by the DBR methodology and due to the cross-context nature of seamless learning, we employed a variety of data collection and analytical methods. Among them, we conducted pre- and post-tests to assess students’ learning gains in idiom-context associations, and administered two post-questionnaires. Questionnaire 1 is for the students to self-report facts and perceptions of their learning experiences across various contexts, including those pertaining to learning in the informal settings. Furthermore, to collect data on the students’ artifact creation processes in informal settings, we periodically compiled the artifacts that individual students shared online to become Questionnaire 2, and asked the students to self-report their processes in creating each artifact. Due to the space constraint, we will not describe the complete design and findings of the questionnaires, but will only focus on those related to our analysis on students’ Activity 2 tasks in this paper.

Student responses were coded based on our classification of “three types of cognitive processes in artifact creation” as our findings in the first cycle (see: Wong, Chin, Tan, & Liu, 2010), namely,

- Type-1: with an idiom in mind → object finding/manipulation or scenario enactment → photo taking;
- Type-2: Object/human/scenario encountering → associating with an idiom (immediate association) → photo taking;
- Type-3: Object encountering/manipulation or scenario encountering/enactment → photo taking → associating with an idiom (delayed association).

Our further analysis of the three types of processes, as reported in our prior publication (Wong et al., 2010), suggests that each type of these processes would correspond to a vocabulary learning strategy. We consider Type-1 the easiest, perhaps an assignment-minded process which could serve as an entry-level activity for newcomers to such activities. Type-2 is the highest level process as such immediate retrieval of the relevant idioms required the students’ internalization of their learned idioms. Type-3 could serve as a bridging strategy between the first two. Descriptive statistics were analyzed to help us understand the trends, which will be reported in the subsequent section.

In our analysis, we distinguished the real-life context and the artifact context. The real-life context is the authentic physical context that facilitates student’s artifact creation. The artifact context is the context that is portrayed by a student artifact and reflects the student’s literal, extended or even creative meaning making of the real-life context where this artifact creation is based on—this is congruent with the notion of LGC. Therefore, the two contexts may or may not be consistent. For example, a student returns home and finds her teddy bear being tossed to the sofa by her younger sister, which is the real-life (authentic) context. She takes a photo of it and composes a sentence, “Exhausted, the bear falls asleep on the sofa.” The sentence reflects an artifact context, which defers from the real-life context since a toy cannot fall asleep—the act of “falling asleep” is merely in her imagination, i.e., “creative meaning making.”

Furthermore, by referring to students’ responses to the questionnaire, we identified several students who went through complex artifact creation processes and generated quality artifacts. We conducted additional one-to-one interviews with them in order to find out the processes of creating individual artifacts and the sources of inspiration. We then interviewed their parents for data triangulation. Due to space constraint, we will only present cases of artifact creation processes of two students, Colin and Jane (pseudonyms), and associating the processes with the above-stated three-type classification. They essentially represent two different types of “habits” in Activity 2, which we will explicate in the following section.

## Findings

### Descriptive statistics of students’ artifact creations

Throughout the second cycle, the students generated 853 sets of artifacts in total. We performed various descriptive statistical analyses on the students’ artifact creations to investigate relevant patterns. Table 1 presents the cross-tabulation of the settings where artifacts were created versus the cognitive processes of artifact creation engendered by the entire class of participating students.

*Table 1.* Cross tab of settings where artifacts were created vs. cognitive process of artifact creation

Settings where artifacts were created	Type-1	Type-2	Type-3	Not sure	Total
During 8 “Activity 1” lessons (small-group co-creation)	52	8	22	3	85
Within the school, not during Activity 1	23	20	20	5	68
At individual students’ home	193	44	134	5	376
Other locations	37	164	110	13	324
Total	305	236	286	26	853

*Note.* whole class; n = 853.

Table 1 was generated on the basis of Questionnaire 2. There were 26 artifacts where the students could not recall the processes behind when they filled up the questionnaire, and were therefore categorized under “not sure”. We distinguished the physical settings where the artifacts were created into four categories—during Activity 1 (teacher-

facilitated group co-creation activities); within the school but not during Activity 1 (e.g., at recess time); at students' home; and at other locations. The last three settings are considered the contexts where students created artifacts spontaneously or by self-initiation, because the teacher did not directly facilitate individual instances of such activities. As stated in the previous section, we are in favor of Type-2 artifacts, since it is an indication of vocabulary internalization, followed by Type-3 artifacts.

Table 1 indicates that the students created the greatest amount of Type-2 artifacts at “other locations.” Through our interviews with the students, we found out that the real-life contexts of “other locations” such as their neighborhoods, shopping malls or other places where they visited during family outings, etc., are less accessible to them in daily life. Students usually did not stay long at such places and might not be able to go wherever they wanted to without adults' company. Henceforth, they were more inclined to apply Type-2 or Type-3 processes in creating artifacts, mostly in an opportunistic, “hit-and-run” manner. In contrast, when they were in school or at home – two familiar locations where they have frequent access to – they tended to apply Type 1 process. This is because they could decide on target idioms upfront and took their time to identify real-life contexts or create artifact contexts (by manipulating objects or getting other people to enact scenarios) for artifact creations.

With this, we argue that carrying out artifact creation activities at “other locations” is the most natural strategy to boost the generations of Type-2 and Type-3 artifacts. Nevertheless, according to what we found out through Questionnaire 1, 11 parents out of the 34 target students forbade their children from bringing the smartphones out of home other than the school due to the fear of their child losing or damaging the devices. That had seriously limited those students' opportunities in creating more artifacts for greater learning gains. However, compared to the first cycle of our study where 21 out of 40 target students' parents imposed the same prohibition, the situation had improved, perhaps due to more parents' buying-in to the notion of seamless learning practice after the “meet-the-parents” session.

We have also run a paired-sample *t*-test to investigate the difference between the students' scores in our pre- and post-tests. The results ( $t = 8.37, p < 0.01$ ) show that the post-test scores are significantly different (improvement) from the pre-test scores.

### Case Study 1: Colin's experiences of artifact creations in informal setting

Colin came from an English speaking family comprising his parents and a 13-year-old elder sister. Prior to our study, his Chinese Language proficiency was low and he disliked the language. His parents checked with him about “Move, Idioms!” only once at the early stage of our study. They then let him carry out the learning activities on his own. Sometimes, Colin requested his parents and sister to be his photo models and enacted specific artifact contexts. His sister usually declined. Therefore, Colin was not keen on involving family members to generate artifacts, other than occasionally asking them to be the photographer.



Figure 2. Two artifacts created by Colin (pseudonym)

Despite that, Colin extended his creativity to overcome the limitation of working alone. Apart from taking photos of objects in their natural settings, such as the furniture and decorations at home, personal encounters in the school and at the neighborhood, and what he came across during family outings, he was good at improvising artifact contexts at home with the physical resources available. Figure 2 features an artifact created by him. The original idioms are underlined in the students' Chinese sentence. To benefit international readers, we translated the sentences into

English with the translations of the idioms underlined. We will do likewise on the student artifacts featured in Figure 3 and Figure 4.

In Figure 2, the photo of Colin at the left was taken five years ago by his father with a digital camera when the family visited the USA. His cognitive process in creating this artifact is described below (interview with Colin, November 9, 2010),

1. He casually browsed through the digital photo album of the tour, encountered this photo and instantly associated it with the idiom 闷闷不乐 (depressed). [Cognitive process Type-2]
2. Having told by the teacher that he should give his artifact a proper context, he could either explain the reason of being depressed, or make a twist in the plot. He went for the latter by imagining his mother gave him something to cheer him up. He saw a variety of stationery on his table and decided to use that as a prop to take a new photo. He associated that with the idiom 各种各样 (a variety of). [Type-2]
3. He brought the two photos together and wrote the first sentence. He then extended the story to incorporate two more idioms: 手舞足蹈 (dance with joy) and 兴高采烈 (with great delight), and wrote the second sentence. [Type-3]

In a separate note, Figure 3 depicts how Colin manipulated different combinations of his (and his sisters') toys to create multiple artifact contexts over a period of seven months. Often, whenever he got hold of a new toy, the first thing that came across his mind was to create artifacts out of it or combined it with his existing toys to create artifacts. In some cases (such as the artifact at the bottom right corner of Figure 3), his artifact contexts were inspired by his earlier real-life experiences or encounters elsewhere.

Table 2 presents the overall statistics of Colin's artifacts. From the table, we observe that although Colin was allowed to bring his smartphone out of home to take photos at "other locations", he generated more artifacts at home, most of which belonging to Type-1 and Type-3 artifacts. The number of his Type-3 artifacts (110) had exceeded the sum of his Type-1 and Type-2 artifacts (61+39=100).

 <p>三五成群的车子正在等进去动物园。 The cars in <u>groups of three or four</u> are waiting for entering the zoo. (April 7, 2010)</p>	 <p>这里人山人海，真热闹！ There is <u>a sea of people</u> here. It's so crowded! (May 20, 2010)</p>	 <p>发生车祸了，三五成群的路人都在看。 It's a car accident. Passers-by are gathering in <u>groups of three or four</u> to watch it. (May 20, 2010)</p>	 <p>这些人争先恐后地争着过马路。 These people are <u>scrambling</u> to cross the road. (May 20, 2010)</p>
 <p>这两个人看起来一模一样的，可能是双胞胎。 They look <u>alike as two peas</u>. They are probably twins. (May 20, 2010)</p>	 <p>一位路人看到了车祸，吓得目瞪口呆。 A passer-by witnessed the car accident and was <u>dumbfounded</u>. (May 20, 2010)</p>	 <p>他目不转睛地看着这辆车子。 He <u>never took his eyes off</u> the car. (May 20, 2010)</p>	 <p>这些车子争先恐后，很容易发生意外。 These cars are <u>scrambling</u> and are therefore prone to accidents. (October 13, 2010)</p>

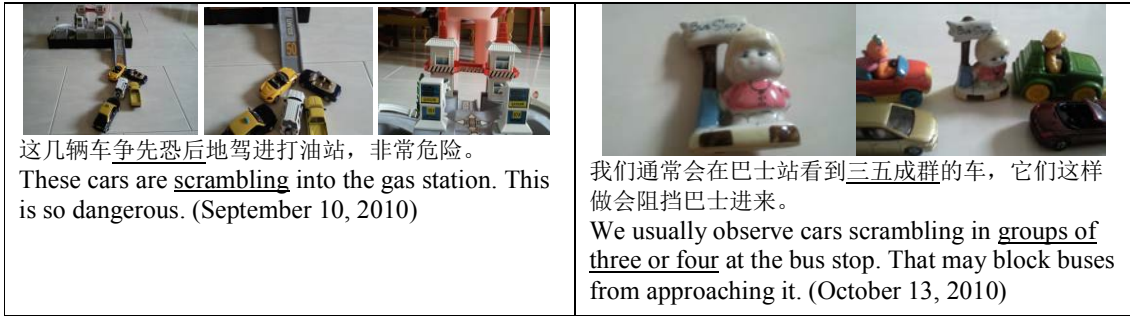


Figure 3. Various artifact contexts created from the same sets of toys by Colin

Table 2. Cross tab of settings where artifacts were created vs. cognitive process types

Settings where artifacts were created	Type-1	Type-2	Type-3	Not sure	Total
During “Activity 1” lessons (small-group co-creation)	8	0	2	2	12
Within the school, not during Activity 1	2	0	3	7	12
At individual students’ home	44	10	65	3	122
Other locations	7	29	40	6	82
Total	61	39	110	18	228

Note. Colin’s artifacts; n = 228.

As a student who used to dislike Chinese, it was amazing that he had been so motivated to create such a huge amount of artifacts. Over time, his artifacts were getting more enriched and substantial. On August 12, 2010, for example, he set the class record of writing a 600-word paragraph describing his experience in attending the National Day Parade, with 17 photos incorporated in the artifact (Type-3 process). Whereas he could have re-used the photos to create multiple but relatively simple one-sentence, one-photo artifacts, he went for the tedious route.

Table 3 presents pre- and post-intervention measurements (as compared to the class means) as evidences of his considerable improvement in the language. We acknowledge that we are uncertain whether his improvement can be solely attributed to our “Move, Idioms!” intervention. However, we did observe his more enriched contents and the increase and more accurate use of idioms and other vocabularies in his in-class compositions.

Table 3. Pre- and post-intervention results of Colin vs. class means in Chinese Language

		Colin’s result	Class mean
“Move, Idioms!” instruments (full scores = 50)	Pre-test	32.0	35.7
	Post-test	43.0	42.7
Year-end school exam (Chinese composition) (full scores = 40)	Previous year	14.0	28.1
	Current year (after intervention)	32.0	30.6
Year-end school exam (full Chinese paper) (full scores = 100)	Previous year	75.5	78.6
	Current year (after intervention)	89.5	81.4

### Case Study 2: Jane’s experiences of artifact creations in informal settings

Jane came from a predominantly Mandarin-speaking family comprising parents and an 8-year-old younger sister. She was competent in the use of Chinese Language within her class but slightly above average in the entire Primary 5 level in the school. However, she perceived herself to be more fluent in English and preferred to use the language (pre-interview with Jane, January 21, 2010). Jane’s mother who attended the meet-the-parents session responded to our call for working with her child in artifact co-creations. Often, it was the mother who proactively gave Jane opportunistic ideas and urged her to carry on. The mother argued that such a collaborative way of learning was effective in further improving Jane’s Chinese Language competency and would like to encourage other parents to do the same (interview with Jane’s mother, November 15, 2010).



With her mother's support, Jane was very motivated in carrying out Activity 2 and took pride of the artifacts that she created alone or with her family. Furthermore, her younger sister was far more cooperative than Colin's elder sister in modeling for her photo taking (and loved to participate in idea brainstorming), perhaps being younger and showy. In the process, her sister had also learned many Chinese idioms.


 <p>(4a) 我有一把五颜六色的雨伞。 I have a colorful umbrella. (July 20, 2010)</p>	 <p>(4b) 本来想和朋友在这里玩耍可是，当我看到这些预告时，我闷闷不乐，一言不发地走开。这里不能踢球，随手丢垃圾，流滑板 and 停脚踏车。 I wanted to play with my friends here. However, when I saw the sign, I was depressed and walked away speechless. Soccer game, littering, skating and cycling are prohibited here. (July 20, 2010)</p>	 <p>(4c) 游客们都千里迢迢来观赏新加坡的摩天观景轮。他们一边观赏一望无际的美景，一边对新加坡的美景赞不绝口。 Tourists come from far off distances to visit Singapore Flyer. They were watching the vast stretch of beautiful scenery while (and) raving about it. (Aug 9, 2010)</p>
--	--	--

Figure 4. Three artifacts created by Jane (pseudonym)

Figure 4 illustrates three examples of Jane's artifacts. Figure 3a and 3b were inspired by the same real-life context – Jane carrying an umbrella. However, she created two different artifact contexts (i.e., LGC) out of it. Her process in creating these artifacts is shown below (post-interview with Jane, November 9, 2010),

1. Her mother fetched her after school. On their way home, she thought she could make a sentence pertaining to her colorful (idiom: 五颜六色) umbrella. She passed her mother her smartphone to take a photo of her back, carrying the umbrella. [Type-2]
2. She checked the photo on her smartphone, and associated it with two other potential idioms: 闷闷不乐 (depressed) and 一言不发 (speechless). [Type-3]
3. She decided to make another sentence by improvising a different context to explain why she looked depressed and speechless in the photo. She noticed the sign (see the first two photos from the left in Figure 4(b)) on the wall at the void deck of a residential apartment nearby. She came out with the idea of not being able to play with her friends due to the prohibitions.
4. The mother-daughter duo carried on their way home. Her mother advised her to take another photo to further depict that “she left the place speechless.” She took a photo of the empty corridor right outside their apartment (a different apartment block from they took the photos of the sign) for that purpose.
5. Upon returning home, she made the sentence in Figure 4(a) with the umbrella photo. She then ordered the four photos taken for the second context and made the three sentences in Figure 4(b).

Whilst Jane was essentially autonomous in creating artifacts in Figures 4(a) and 4(b) with her mother's just-in-time, peripheral support, Figure 4(c) is a typical example of the mother-daughter co-creation activities that occurred during the generation processes of many other artifacts. The cognitive process is described below,

1. Jane took a snapshot of the Singapore Flyer, a touristic attraction, with her smartphone on a highway when her family was on their way to visit the Open Day of *Istana*, the office of the President of Singapore. She took many other photos in *Istana*.
2. Upon returning home, her mother urged her to check the photos in the smartphone. She wrote a few paragraphs and sentences with the photos taken in *Istana*. When they encountered this snapshot, her mother proposed a sentence opener, “Tourists come from far off distances (千里迢迢) ....” [Type-3]
3. Jane wrote, “Tourists come from far off distances to visit Singapore Flyer.” Her mother then reminded her that she had just learned the conjunction “一边 xx 一边 yy” (“(doing) xx while (doing) yy”) in the previous “Activity 1” session and that could be utilized to extend her write-up. [Type-3]
4. She thought of incorporating two idioms to “xx” and “yy” respectively in the sentence structure of “xx while yy”. She wrote, “They were watching the vast stretch (一望无际) of beautiful scenery while (and) raving about (赞不绝口) it.” [Type-3]

Jane usually worked alone or worked with her mother in co-creating artifacts. However, there were also times where she had also worked with her sister, with or without her mother's presence. Jane's mother informed us that she had often brought Jane to explore various local places of interest (more frequently than in the past), mainly for carrying out Activity 2. Even though the smartphone used in such an activity can be replaced by a digital camera and paper and pen, Jane's mother preferred Jane to use the phone, as she quipped, "Jane would be lazy to use paper and pen to write." (interview with Jane's mother, November 15, 2010)

Table 4 shows the overall statistics of Jane's artifacts. Jane was certainly more outgoing than Colin as the number of artifacts that she created at "other locations" (157) doubled the sum of those she created in the school and at home ( $4+8+62=74$ ). The amount of her Type-3 artifacts (130) had also exceeded the sum of her Type-1 and Type-2 artifacts ( $63+38=101$ ). We tracked her monthly posting statistics and discovered that her artifact creation activities in informal settings had shifted from predominantly Type 1 to predominantly Type-3, plus a healthy amount of Type-2 artifacts created at "other locations". This is because she had gradually been venturing into creating more complex artifacts, i.e., taking a set of photos with a coherent artifact context, and then sitting down, taking her time to compose and extend a paragraph that utilized multiple idioms, often with her mother's participations (e.g., Figure 4(c)).

*Table 4. Cross tab of settings where artifacts were created vs. cognitive process of artifact creation*

Settings where artifacts were created	Type-1	Type-2	Type-3	Not sure	Total
During "Activity 1" lessons (small-group co-creation)	3	0	1	0	4
Within the school, not during Activity 1	2	3	3	0	8
At individual students' home	47	5	10	0	62
Other locations	11	30	116	0	157
Total	63	38	130	0	231

*Note.* Jane's artifacts;  $n = 231$ .

Table 5 reveals the pre- and post-intervention results of Jane as indicators of her improvement in Chinese Language.

*Table 5. Pre- and post-intervention results of Jane vs. class means in Chinese Language*

		Jane's result	Class mean
"Move, Idioms!" instruments (full scores = 50)	Pre-test	35.0	35.7
	Post-test	49.0	42.7
Year-end school exam (Chinese composition) (full scores = 40)	Previous year	30.0	28.1
	Current year (after intervention)	36.0	30.6
Year-end school exam (full Chinese paper) (full scores = 100)	Previous year	81.5	78.6
	Current year (after intervention)	86.3	81.4

## Discussion

In this section, we will rise above our learning design and research findings to foreground the following aspects,

- To advance the mobile learning field's understanding in the roles that the mobile technology and the mobile learning model would play in seamless learning
- The study's implications on authentic, productive language learning
- To investigate how the notion of LGC is crystallized in the seamless learning processes, especially in the informal learning settings, with or without parental involvement

### The roles of mobile technology in seamless learning

Looi, Wong and Song (in press) foregrounded two main characteristics of mobile learning, namely, (a) mobility: Learning no longer happens in a fixed physical place, but occurs in environments that move with the learners; (b) personalization: Learning is more personalized in a continually reconstructed contexts. The new focus is laid on

LGC that could occur in any physical or virtual space, with individual learners having greater control over what and how they learn (Sharples, Taylor, & Vavoula, 2007). In the context of our study, what we have strived to achieve is to facilitate the students in enacting holistic, seamless learning experiences that are rooted in such notions, with the exploitation of both the mobile affordances of mobility and personalization.

What roles did the technology play in “Move, Idioms!”? At first glance, the smartphones seemed to be used in a minimalist way – for photo taking, sentence making and artifact uploading. However, it was our learning design that helped the students in maximizing their learning by exploiting the affordances of mobile learning—mobility and personalization. The instant playback feature of the built-in camera enabled one to check a photo immediately after shooting, and decided whether a retake was needed to make sure her idea was correctly executed and the idiom association was appropriate. In some rare cases, checking the playback might even instantly trigger new ideas (e.g., Figure 3a and Figure 3b).

Through our analysis of student artifacts and the post-interviews, we have also noticed that many students often browsed through and tidied up their photo albums on their smartphones that contained photos taken across locations and time. That prompted some of them to create new artifacts arisen from those “older” photos, or even picking and mixing several photos to create more artifacts—Figure 2a is a similar case, except that the first photo was taken with another camera. In these cases, the students had transformed their smartphones from a productive tool to a cognitive tool. We consider this a potentially new characteristic of seamless learning, on top of the ten major characteristics/dimensions of seamless learning that Wong and Looi (2011) have expounded—the choices and the seamless synthesis of suitable learning resources that a learner picked up (and perhaps all stored in her personal mobile device as a “learning hub” (Wong, 2012)) along her on-going learning journey to mediate the latest learning task.

### The implications on authentic, productive language learning

Building on our findings in the previous DBR cycle of study, we further investigated and reflected upon the characteristics of the three types of cognitive processes in artifact creations, which we summarize in Table 6.

Table 6. Comparison between three types of cognitive processes in artifact creations

Type-1	Type-2	Type-3
Assignment-like artifact creation process with relatively prescribed artifact contexts to identify	Immediate, opportunistic, spontaneous idiom-to-context association	Spontaneous photo taking; delayed idiom-to-context association
Good for form-meaning connection in vocabulary learning	Good for context-meaning connection (i.e., use of vocabulary) in vocabulary learning	Good for context-meaning connection in vocabulary learning and extension of the artifact context
Mostly taking place in the school or at home	Mostly taking place at “other locations”	Mostly taking place at home or at “other locations”

We consider the classification and statistical analysis of the students’ artifacts in the three types as a potentially effective technique in evaluating the students’ learning outcomes in the “Move, Idioms!” intervention. Based on our analysis, the application of the Type-2 creation process (and to a lesser extent, the Type-3 process), requires students to genuinely internalize the vocabulary that they have learned—so that they can immediately react to their daily encounters and retrieve the right vocabulary to describe the situations. Therefore, the amount of (correct) Type-2 artifacts created by the students may serve as an indicator of students’ deep learning.

While we favor Type-2 artifacts, we do not discriminate two other types of artifacts. The creation of Type-1 artifacts may serve as a strategy for the students’ deep learning of individual idioms in order to achieve internalization. Our concern is on how to elevate those students who stick to creating Type-1 artifacts most of the time (e.g., 15 out of 34 students in our study created more Type-1 artifacts than the sum of Type-2 and Type-3 artifacts) to create more Type-2 and Type-3 artifacts for a more balanced vocabulary development.

As stated before, we observed that being more “outgoing” (visiting “other locations”) is a natural strategy to boost the creation of Type-2 and Type-3 artifacts. However, as our target students are at their tender ages, we need to respect some parents’ stance of forbidding their children from bringing the smartphones out of home. An alternative strategy is to enact more classroom activities (i.e., Activity 1) that aim for building Type-2 skills among the students. Examples are flashing context-rich photos generated by their peers and invite them to brainstorm for as many relevant idioms as possible, and small-group artifact co-creation activities that are restricted to generating Type-2 artifacts. Students will then be encouraged to bring over the skills to their personal artifact creation activities at home.

### **Informal learning settings and learner generated contexts**

Contexts, especially the Learner Generated Contexts, are the core of our analysis on the students’ learning processes and artifacts in this paper. The role of authentic contexts in most of the existing MALL studies has been restricted to scoping learners’ language learning processes through technology-mediated (in particular, context-aware technology) pushing of *in-situ*, “context-appropriate” content and scaffolds (Kukulska-Hulme & Wible, 2008), i.e., to position learners merely as the behaviorist consumer of externally facilitated contexts. Examples of such studies are reported in Chen and Li (2010), Ogata, Akamatsu and Yano (2004), and Sandberg, Maris and de Geus (2011). Instead, our study emphasizes LGC as a means to stimulate language-mediated constructivist, active meaning making and reflections on their real-life experiences. With proper enactment of such learning designs, we argue that our novel positioning in language learning will result in a greater level of language internalization.

Furthermore, we have also foregrounded the value of family members, especially parental involvements in their children’s mobilized learning and learner context generation in informal settings. In our study, the parents’ roles had gone beyond monitoring learning progresses or pushing for drill-and-practice, but motivating and supporting their children’s learning which had been blended into their family life. The discourses between Jane and her mother exemplify how family-based socio-constructivist learning may effectively inspire children to push their boundary in carrying out their learning tasks.

Conversely, even without substantial involvement of his family members as what Jane had been enjoying, Colin turned his home into his personal learning and creative playground where he could appropriate suitable physical or digital resources to mediate his artifact creation. With the notion of LGC in mind, we found that what informal learning settings could offer to such a less structured learning activity (i.e., requiring greater spontaneity [mobility] and wit [personalization]) is virtually limitless.

In this regard, we re-conceptualize the nature of “seamless learning environment” from an individual learner’s perspective by adapting Barron’s (2006) definition of learning ecology (see the Literature Review section) as “the combination of physical or virtual (living) spaces that a person is situated or encounters in his/her daily life that provides opportunities for learning.” We remove the wording “contexts found in ...” from the original definition in recognizing the potential for LGC from the resources found in each living space; and to carry out a learning activity can be viewed as the act of generating a learning context. The opportunities for learning are always there. It is up to an individual who has established the habit of mind and competencies of seamless learning to identify and appropriate such opportunities to advance her learning.

### **Conclusion**

We have unpacked the students’ artifact creation processes in the seamless language learning experience of “Move, Idioms!”, particularly those taking place in informal settings. Through the qualitative and statistical investigation of students’ cognitive processes in artifact creations, we identified some patterns of such processes and gained better understanding in how physical settings, parents and the technology had played their parts in mediating such learning tasks. Indeed, there were isolated expositions or studies on these three aspects of learning. However, none of the studies had synthetically investigated the interplay of these three elements within the context of seamless learning in 1:1, 24x7 settings, i.e., how the notion of seamless learning and our *explicit* seamless learning design had brought these elements together to construct a learning environment that is conducive for greater learner autonomy in facilitating LGC.

The significance of the reported study is two folded. First of all, it prompted us to re-conceptualize the nature of seamless learning from an individual student's perspective, i.e., students' self-generation of learning contexts within and across their living spaces. Students should ultimately become life-long autonomous learners who are able to decide when, where and how to learn with self-identified resources within their learning spaces. This salient learning design principle of "Move, Idioms!" marks a major departure from most of the prior mobile learning studies which tended to confine the learners to predefined learning goals and resources within externally imposed, relatively static learning contexts. We argue that our design that stresses diversity (in terms of self-generated contexts and artifacts) and personalization of learning—are the keys to achieve this. That leads to the second significant issue of the study—it sheds light on how we shall refine our learning experience design for the next DBR cycle to foster a more holistic, seamless learning habit and experience among the students. Examples are placing greater emphasis in Type-2 and Type-3 artifact creations during Activity 1 lessons, and introducing measures to motivate more parents' deeper involvements in their children's Activity 2 (and even Activity 3) tasks—so that they will become the children's co-creators of their learning contexts. In short, we hope to contribute to the literature of mobile seamless learning by putting forward the importance of explicit design for seamless learning processes that leverage virtually limitless learning opportunities that informal settings and family member involvements may offer to learners, with the support of mobile technologies; and what it takes for the learners to be able to identify and seize such potential opportunities to enhance their learning.

## Acknowledgements

This research was funded by the Office of Educational Research, National Institute of Education (project ID: OER 14/09 WLH).

## References

- Barab, S., & Roth, W.-M. (2006). Curriculum-based ecosystems: supporting knowledge from an ecological perspective. *Educational Researcher*, 35(5), 3-13.
- Barron, B. (2006). Interest and self-sustained learning as catalysts of development: A learningecologies perspective. *Human Development*, 49(4), 193-224.
- Beals, D. E., & Snow, C. E. (1994). "Thunder is when angels are upstairs bowling": Narratives and explanations at the dinner table. *Narrative and Life History*, 4(4), 331-352.
- Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of Learning Sciences*, 2(2), 141-178.
- Chan, T.-W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., et al. (2006). One-to-one technology-enhanced learning: An opportunity for global research collaboration. *Research and Practice in Technology-Enhanced Learning*, 1(1), 3-29.
- Chen, C.-M., & Li, Y.-L. (2010). Personalized context-aware ubiquitous learning system for supporting effective English vocabulary learning. *Interactive Learning Environments*, 18(4), 341-364.
- Design-Based Research Collective. (2003). Design-based research: an emerging paradigm for educational inquiry. *Educational Researcher*, 32(1), 5-8.
- Dourish, P. (2004). What we talk about when we talk about context. *Personal and Ubiquitous Computing*, 8(1), 19-30.
- Falk, J. H., & Dierking, L. D. (1998). Free-choice learning: An alternative term to informal learning. *Informal Learning Environments Research Newsletter*, 2(1), 2.
- Hill, N. E., & Tyson, D. F. (2009). Parental involvement in middle school: A meta-analytic assessment of the strategies that promote achievement. *Developmental Psychology*, 45(3), 740-763.
- Hull, G., & Schultz, K. (2001). Literacy and learning out of school: A review of theory and research. *Review of Educational Research*, 71(4), 575-611.
- Jiang, N. (2000). Lexical representation and development in a second language. *Applied Linguistics*, 21(1), 47-77.
- Kukulka-Hulme, A., & Wible, D. (2008). Context at the crossroads of language learning and mobile learning. *Proceedings of the International Conference on Computers in Education 2008* (pp. 205-210). Retrieved from: [http://www.apsce.net/ICCE2008/Worshop\\_Proceedings/Workshop\\_Proceedings\\_0205-210.pdf](http://www.apsce.net/ICCE2008/Worshop_Proceedings/Workshop_Proceedings_0205-210.pdf)

- Lewin, C., & Luckin, R. (2010). Technology to support parental engagement in elementary education: Lessons learned from the UK. *Computers & Education*, 54(3), 749-758.
- Lonsdale, P., Baber, C., & Sharples, M. (2004). Engaging learners with everyday technology: A participatory simulation using mobile phones. *Proceedings of the International Symposium on Mobile Human-Computer Interaction 2004* (pp. 461-465). Retrieved from: <http://www.peterlonsdale.co.uk/papers/mobilehci-lonsdale.pdf>
- Looi, C.-K., Wong, L.-H., & Song, Y. (in press). Discovering mobile computer supported collaborative learning. In C. Hmelo-Silver, A. O'Donnell, C. Chan & C. Chinn (Eds.), *The International Handbook of Collaborative Learning*. New York, NY: Routledge.
- Luckin, R. (2008). The learner centric ecology of resources: A framework for using technology to scaffold learning. *Computers & Education*, 50, 449-462.
- Noel, K. A. (2001). New orientations in language learning motivation: Towards a model of intrinsic, extrinsic, and integrative orientations and motivation. In Z. Dörnyei & R. Schmidt (Eds.), *Motivation and Second Language Acquisition* (pp. 43-68). Honolulu, HI: University of Hawaii, Second Language Teaching and Curriculum Center.
- Ogata, H., Akamatsu, R., & Yano, Y. (2004, August). *Computer supported ubiquitous learning environment for vocabulary learning using RFID tags*. Paper presented at the Workshop on Technology Enhanced Learning '04, Toulouse, France.
- Sandberg, J., Maris, M., & de Geus, K. (2011). Mobile English learning: An evidence-based study with fifth graders. *Computers & Education*, 57(1), 1334-1347.
- Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews & C. Haythornthwaite (Eds.), *The Sage Handbook of E-learning Research* (pp. 221-247). London, UK: Sage.
- Tedick, D. J., & Walker, C. L. (2009). From theory to practice: How do we prepare teachers for second language classrooms? *Foreign Language Annals*, 28(4), 499-517.
- Titone, R. (1969). Guidelines for teaching second language in its own environment. *The Modern Language*, 53(5), 306-309.
- Whitworth, A. (2008). Learner generated contexts: critical theory and ICT education. *Proceedings of the Panhellenic Conference on Information and Communication Technologies in Education 2008* (pp. 62-69). Retrieved from: [http://www.etpe.eu/files/proceedings/23/1236077186\\_09.%2020%20p%2062\\_70.pdf](http://www.etpe.eu/files/proceedings/23/1236077186_09.%2020%20p%2062_70.pdf)
- Wong, L.-H. (2012). A learner-centric view of mobile seamless learning. *British Journal of Educational Technology*, 43(1), E19-E23.
- Wong, L.-H., Boticki, I., Sun, J., & Looi, C.-K. (2011). Improving the scaffolds of a mobile-assisted Chinese character forming game via a design-based research cycle. *Computers in Human Behavior*, 27(5), 1783-1793.
- Wong, L.-H., Chen, W., & Jan, M. (2012). How artefacts mediate small group co-creation activities in a mobile-assisted language learning environment? *Journal of Computer Assisted Learning*, 28(5), 411-424.
- Wong, L.-H., Chin, C.-K., Tan, C.-L., & Liu, M. (2010). Students' personal and social meaning making in a Chinese idiom mobile learning environment. *Educational Technology & Society*, 13(4), 15-26.
- Wong, L.-H., & Looi, C.-K. (2010). Vocabulary learning by mobile-assisted authentic content creation and social meaning-making: Two case studies. *Journal of Computer Assisted Learning*, 26(5), 421-433.
- Wong, L.-H., & Looi, C.-K. (2011). What seems do we remove in mobile assisted seamless learning? A critical review of the literature. *Computers & Education*, 57(4), 2364-2381.